Honeywell

# Report
for
xxxxxxxxxx
# LCN Audit – Date xxxxx

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| **Customer xxxxxxxx**<br>**Approved by:** | **Signed:** | **Date:** |

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Honeywell Limited
Address xxxxxxxxx
Contact details: xxxxxxxxxx

**Revision Status**

| Revision | Date | Prepared By | Description |
|---|---|---|---|
| **0** | **xxxxxxxx** | **Honeywell** | **Original Issue** |

*Note: Modifications will be indicated by a revision change bar in the left hand side margin.*

**Revision Summary**

The following sections were added to (A), modified (M) or deleted (D) from the previous issue/revision.

| Section | Change | Description |
|---|---|---|
| | | |
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**General Revisions**

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# *1.* Abbreviations and Definitions

## *1.1. Abbreviations*

The following abbreviations used in this document are defined as:-

| Abbreviation | Definition |
|---|---|
| AI | Analogue In |
| AO | Analogue Out |
| CER | Central Equipment Room |
| Customer | xxxxxxx |
| Display | Native Window Operator Graphic |
| DCS | Distributed Control System |
| DI | Digital Input |
| DO | Digital Output |
| EXPERION | Honeywell Experion PKS |
| GUS | Global User Station, (DCS Operator interface) |
| HM | History Module |
| HPM | High-Performance Processor Manager |
| HWL | Honeywell Limited |
| I/O | Input / Output |
| LCN | Local Control Network, (now known as TPN) |
| LCS | Honeywell LCS 620 PLC system |
| MAU | Media Access Unit |
| NIM | Network Interface Module |
| OP | Output |
| P&ID | Piping and Instrumentation Diagram |
| PC | Personal Computer |
| PHD | Process History Database |
| PID | Proportional Integral Derivative |
| PLC | Programmable Logic Controller |
| Points | DCS / SCADA entities |
| PV | Process Variable |
| SCADA | Supervisory, Control and Data Acquisition |
| Schematic | Honeywell DCS Legacy Custom Graphic |
| SI | Serial Interface I/O |
| SP | Setpoint |
| TPS | Honeywell **TotalPlant**® Solution System |
| TPN | TPS Network |
| UCN | Universal Control Network |
| US | Universal Station, (Honeywell legacy DCS Operator interface) |
| UxS | US with a Unix Co-processor, (X layer) |
| Workstation | US contained in a stand alone desk side unit |

### *1.2. Definition of Terms*

| | |
|---|---|
| Goods | Equipment or software. |
| Equipment | Equipment manufactured by Honeywell, its affiliates and bearing the Honeywell nameplate. |
| Services | Honeywell labour, or Honeywell service as provided under a Honeywell Service Agreement. |
| Software | Computer programs sold by Honeywell in the form of machine readable instructions or documentation of produce literature bearing the Honeywell name. |
| Errors | Are limited to the failure of goods to perform a function as described in the Honeywell proposal or the Honeywell Functional Specification for those goods or, in the case of standard goods, limited to the failure of goods to perform a function as described in the appropriate Honeywell User Manual or Honeywell product literature. |
| Defects | Any deficiency, flaw, weakness or other fault, excluding errors, of any kind to which the goods may be subject. |
| Non HWL Goods or Services | Equipment, documentation, product literature, labour, knowledge, service or computer programs in the form of machine readable instructions, that is supplied, installed or provided by a person other than Honeywell. |
| Operator | The person responsible for operating the Plant. |

## *2.* Introduction

### *2.1. Purpose of this Document*

The purpose of this LCN audit is to generate a report and suggested corrective actions to be taken based on an inspection done at the xxxxxxxxx. This document is to be reviewed and approved by the Customer.

### *2.2. System Architecture*

The Control System at xxxxxxxx consists of Universal stations, GUS, Application Modules, APP Nodes, Highway Gateways, Network Interface Modules, History Modules, Experion Servers and Experion Stations.

The current LCN version at xxxxxxxx is Rxxxxxx.

The Local Control Network (LCN) is a token bus network that is implemented in 75 ohm coaxial cable. The bus is terminated at each end and each node on the bus is transformer isolated from the bus. The LCN has two physically separate redundant copies, LCN A and LCN B, so there are actually two networks.

The Operator Consoles in the control room uses Group, Trend, Detail and Custom Displays as the interface to mimic and control the plant.

## *3.* Scope

The scope of work for this audit;

- Inspect and document all LCN Connections.
- Inspect and review all MAU devices on the LCN.
- Inspect and document all LCN node earthing.
- Review and summarise all LCN Error statistics.
- Review and document any standing System alarms.
- Review and document all current history module journals for System errors.

This is a passive audit where no active testing of cabling, system testing or performing any interruptions to the LCN cables was under taken.

## *4.* Inspection report

The inspection report is divided into two sections: The first section is detailed as the hardware inspection and the second section is the review of the system diagnostics and system journals.

### *4.1. Hardware Inspection*

Below is a summary of the equipment inspected. Appendix A is an Excel spreadsheet containing all the information on the LCN hardware inspection.

#### 4.1.1. Media Access Units

All MAU's founded are the newer type i.e. case manufactured from aluminium. Details are found in BeAware advice BW 98010. A copy of the BeAware notice is provided in Appendix??

The MAU's are located at LCN node addresses, 20, 21, 22, 38, 39, 40, 44, 55, 58. Other MAU's were found but not connected to TPS hardware. (These are noted in Appendix A)

Also Gus 44 MAU is displaying signs of corrosion due it its location near a sub floor air-conditioning duct.

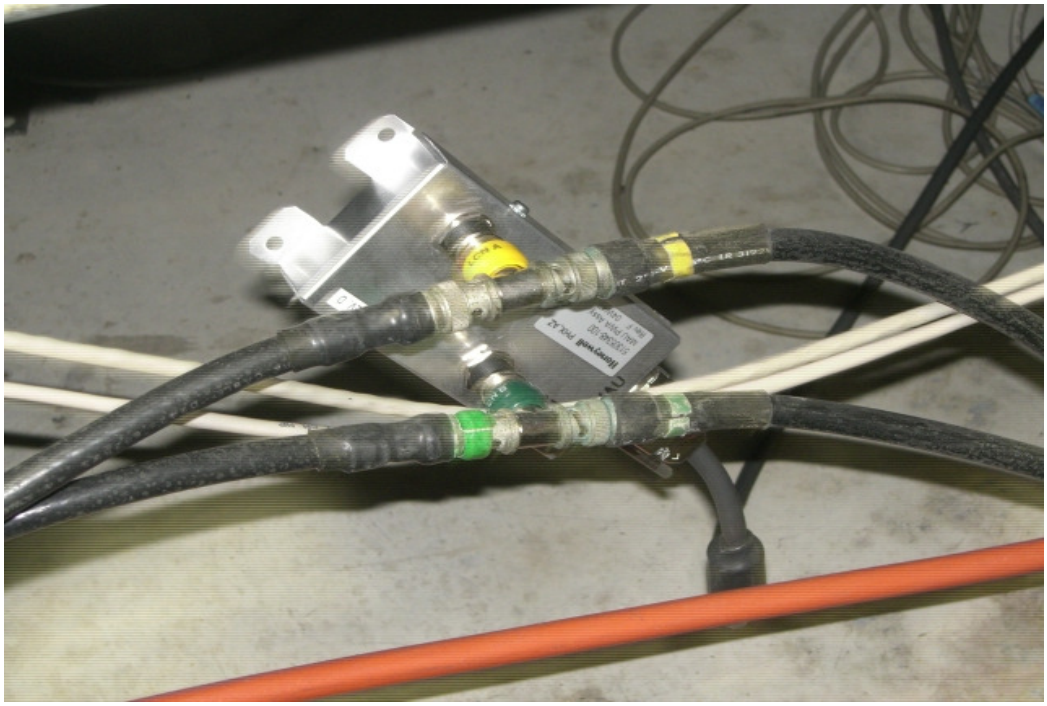


*Figure 1 MAU at Node 44 hanging on power cables*

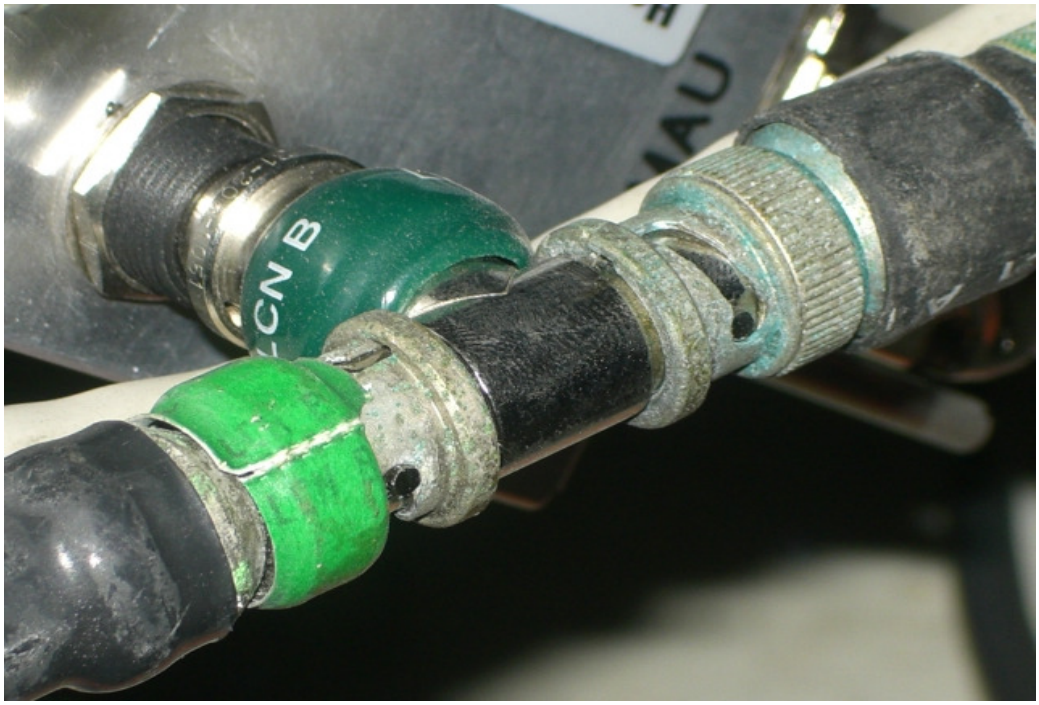



*Figure 2 MAU at Node 44 show signs of corrosion*

4.1.2. LCN Grounding Principles

xxxxxxx uses Non CE equipment and the following must apply on the grounding of equipment:

The required grounds and their connections including design are discussed below;

Five-Slot Modules are grounded according to the type of node present in the module. Universal Stations have the logic ground terminal connected to chassis ground.

All other LCN nodes have the logic ground connected to MRG.

Dual Node Modules require grounding of both nodes in the module according to the type of node present in the module.

- Hiway Gateways (HG) have the logic ground connected to MRG.
- All other node types have the logic terminal connected to chassis ground.
- Redundant gateways (HGs, NIMs, and PLCGs) must be located in separated Dual Node Modules.

For safety reasons the outer conductor of the coaxial cable is grounded to chassis at one location.
The following items are noted as not meeting the requirements

- LCN cable earthing is not implemented. This should ground A and B cables and not to be grounded at the same node. LCN A and B should be grounded in 37-CAB-LCN1 at NIM 23 or NIM 24

respectively. They should also be grounded in 37-CAB-LCN6 at NIM 47 and NIM 48 respectively.

**Note this connection can be made by installing CS/R I/O (51304286) boards. The CS/R's provide a connection from the BNC outer conductor to chassis on the PWB. As this time we cannot confirm installation of these boards based that the part number is not visible.*

- LCN Cables are joined by Tee connectors, this is not recommended for use of extending cable lengths. Only where a physical connection is required to a LCN node.
- On US stations, Logic and Chassis ground must be shorted, this is not implemented on nodes 5, 6, 8, 9, 31, 32, 33, 34, 35, 36, 37 (Also note node 8 has no chassis ground connection)

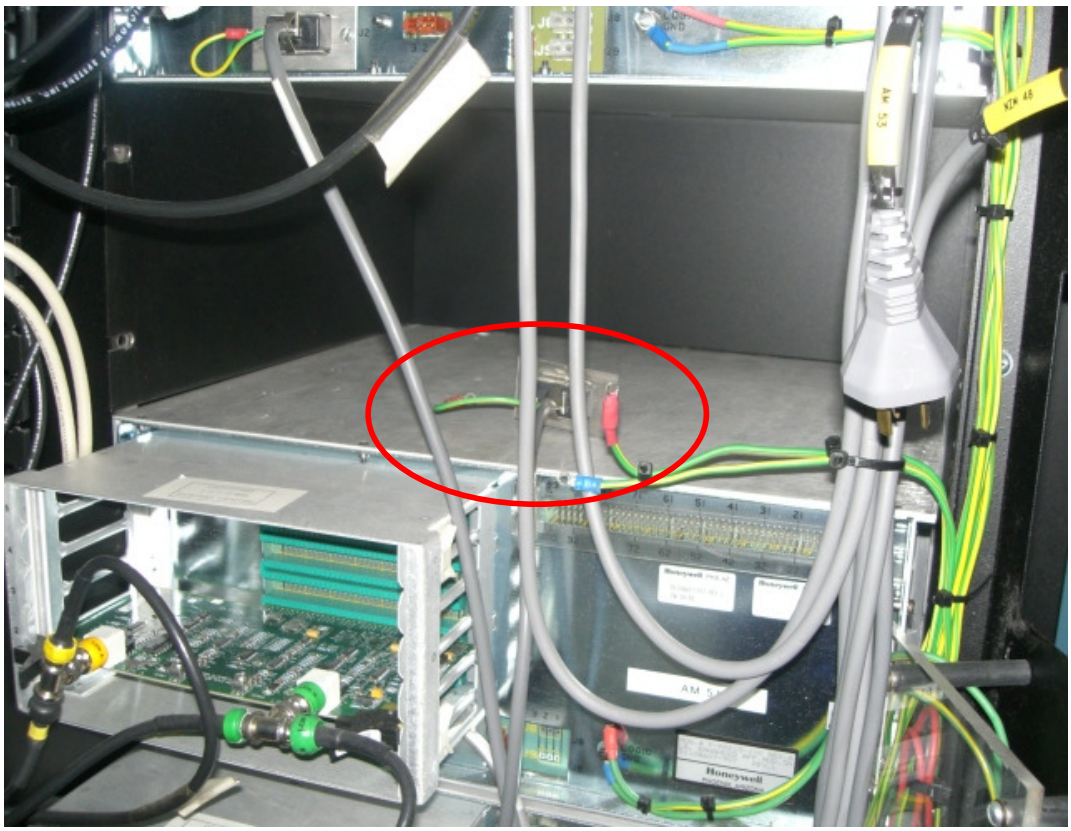


*Figure 3 Unterminated Earth cabling from removed node.*

Ground guidelines can be found in reference document; TPS System Site planning (SW02-550) section 5.

### 4.1.3. HIWAY Grounding Principles

TDC HiWay systems will keep the Master Reference Ground and the Safety Ground. This is outside of scope for the LCN audit.

### 4.1.4. LCN cabling

Currently the LCN cabling does not have reliable source and destination labels. It was unable to determine LCN cable length and cable path. A reliable LCN network diagram was not available for review.

Many LCN cable connections were discovered which appeared to be joining LCN cable together with no LCN nodes present. Each of these open Tee connections, 13 in total found can act to introduce noise and errors to the LCN system.

The LCN A cable must be grounded at a different node as the LCN B cable. However, in mixed ground systems (MRG and Safety Ground) both cables need to be connected to the same ground. i.e. Both connected to MRG but in different nodes or both connected to Chassis Ground but in different nodes.

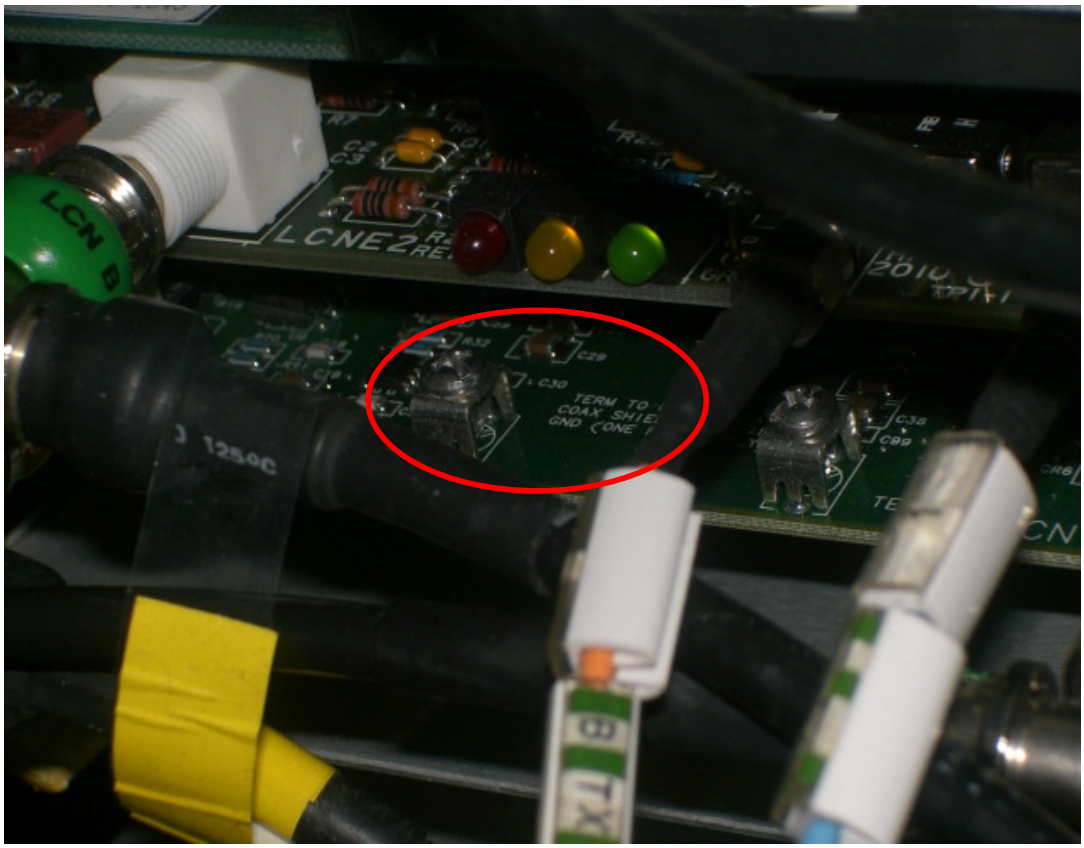



*Figure 4 No earth connection to LCN A*

Routing of LCN coaxial cables is critical to ensure minimal noise coupling. The cables should be isolated from other power and signal cables as much as possible. LCN coaxial cables crossing other cables at 90 degrees is acceptable, but long parallel runs with other cables should be avoided. Also there should be no risk of the LCN metal connectors making contact with other metal components.

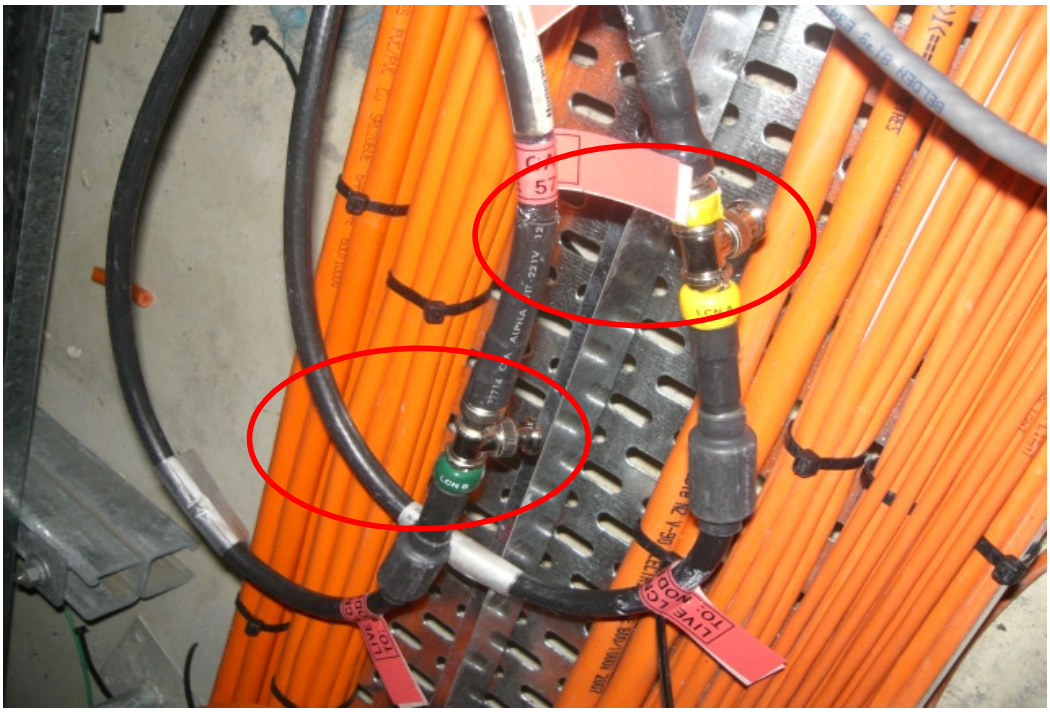


*Figure 5 Open Tee connector near Power cabling*

The bend radius of the LCN coaxial cable should be as large as possible to minimize cable impedance changes. Bend radius less than 0.3 meters are unacceptable on the trunk style cable.

Node 8 is outside the bend radius guide line and there is tension on the LCN connector.

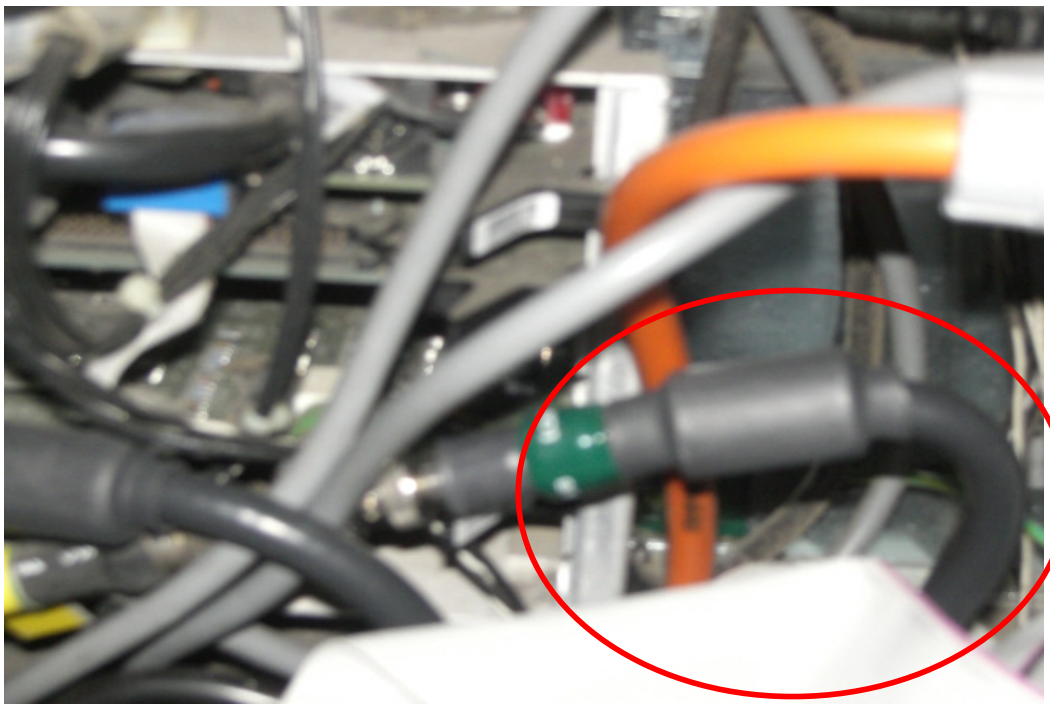


*Figure 6 Bend Radius at Node 8*

### 4.1.5. Environmental Conditions

The air conditioning in the Central Equipment Room (CER) should be checked regularly

System equipment operates over a wide range of temperature and humidity; however, corrosive process materials, contaminants in the air and other realistic considerations may reduce the environmental range that can be placed on the equipment.

The following guidelines limiting the operating ranges are recommended:
- Maintain relative humidity levels between 40% and 50%.
- Control humidity fluctuations to less than 6% per hour rate-of-change.
- Limit the temperature rate-of-change to 1°C/minute on actuation of the air conditioner.

The system at Xxxxxxx is monitored and alarms are generated to warn if the air conditioner is not operating correctly.

### 4.1.6. Other Observations

US Nodes 7, 17, 37 have a build-up of dust.

Experion Node 38, 39, 43 are operating in custom built cabinets and these nodes have a build-up of dust.

Two available LCNE board are installed in nodes 29 & 30 with no fibre connected.

Cabinet 37-CAB-LCN3-Rear: There is a spare fibre optic cable going to Sat room 2 and a spare 3m LCN segment in the bottom of the cabinet.

*Figure 7 Spare Fibre Optics and LCN Segment*

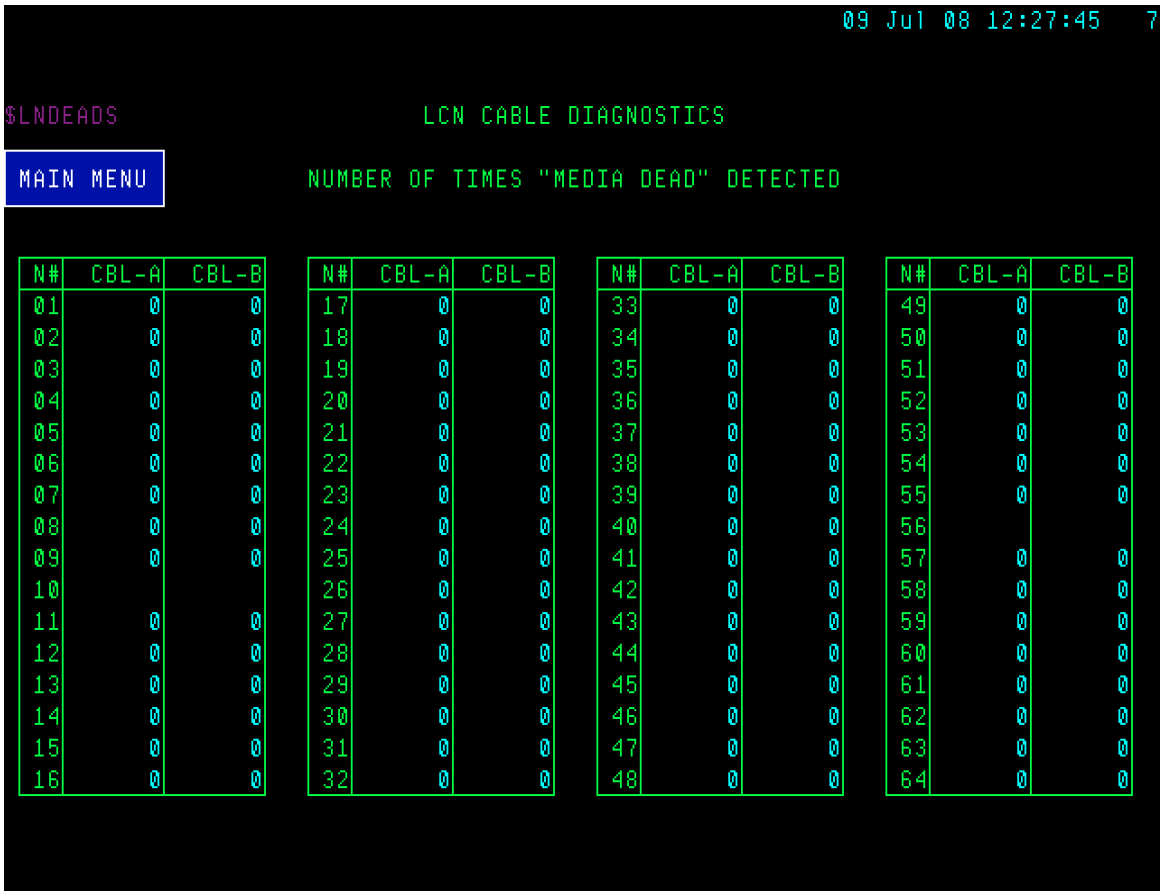
### *4.2. System Software Report*

Below is a summary of the system software report. Appendix A is an Excel spreadsheet containing all the information on the LCN system software.

```
                                                          15 Jul 08 08:26:48   7
ACTIVE MAINT JOURNAL DATA
--------------------------------------------------------------------------------
TIME¦  DATE ¦R¦EVENT¦                    INSTRUCTION
    ¦       ¦M¦ S/N ¦
--------------------------------------------------------------------------------
1236 18Jun08 0139930 US 4 SLOT 5 INVESTIGATE SUSPECT CURSOR DEVICE
1236 18Jun08 0139931 US 4 SLOT 5 INVESTIGATE SUSPECT CURSOR DEVICE
1251 18Jun08 0216945 US 31 SLOT 5 INVESTIGATE SUSPECT CURSOR DEVICE
1312 18Jun08 0100104 US 35 SLOT 5 INVESTIGATE SUSPECT CURSOR DEVICE
1313 18Jun08 0100106 US 35 SLOT 5 INVESTIGATE SUSPECT CURSOR DEVICE
1959 02Jul08 5900001 NIM 23 SLOT 16 REPLACE MARGINAL LCNI Cable-A
2150 04Jul08 0115695 US 4 SLOT 5 INVESTIGATE SUSPECT CURSOR DEVICE
2316 04Jul08 0115754 US 4 SLOT 5 INVESTIGATE SUSPECT CURSOR DEVICE
2317 04Jul08 0115755 US 4 SLOT 5 INVESTIGATE SUSPECT CURSOR DEVICE
1159 05Jul08 5900002 US 32 SLOT 16 REPLACE MARGINAL LCNI Cable-B
1159 05Jul08 5900003 AM 54 SLOT 16 REPLACE MARGINAL LCNI Cable-B
0943 07Jul08 0117435 US 4 SLOT 5 INVESTIGATE SUSPECT CURSOR DEVICE
1040 07Jul08 0117440 US 4 SLOT 5 INVESTIGATE SUSPECT CURSOR DEVICE

--------------------------------------------------------------------------------


  ENTER CA Text   :

  For Information On Functions And Options Displayed On This Menu,
  Position The Cursor On The Desired Target And Press HELP.
```

The event at "NIM 23 SLOT 16 REPLACE MARGINAL LCNI Cable-A" is referring to a problem with communication on cable-A. The same event is present at US 32 and AM 54.

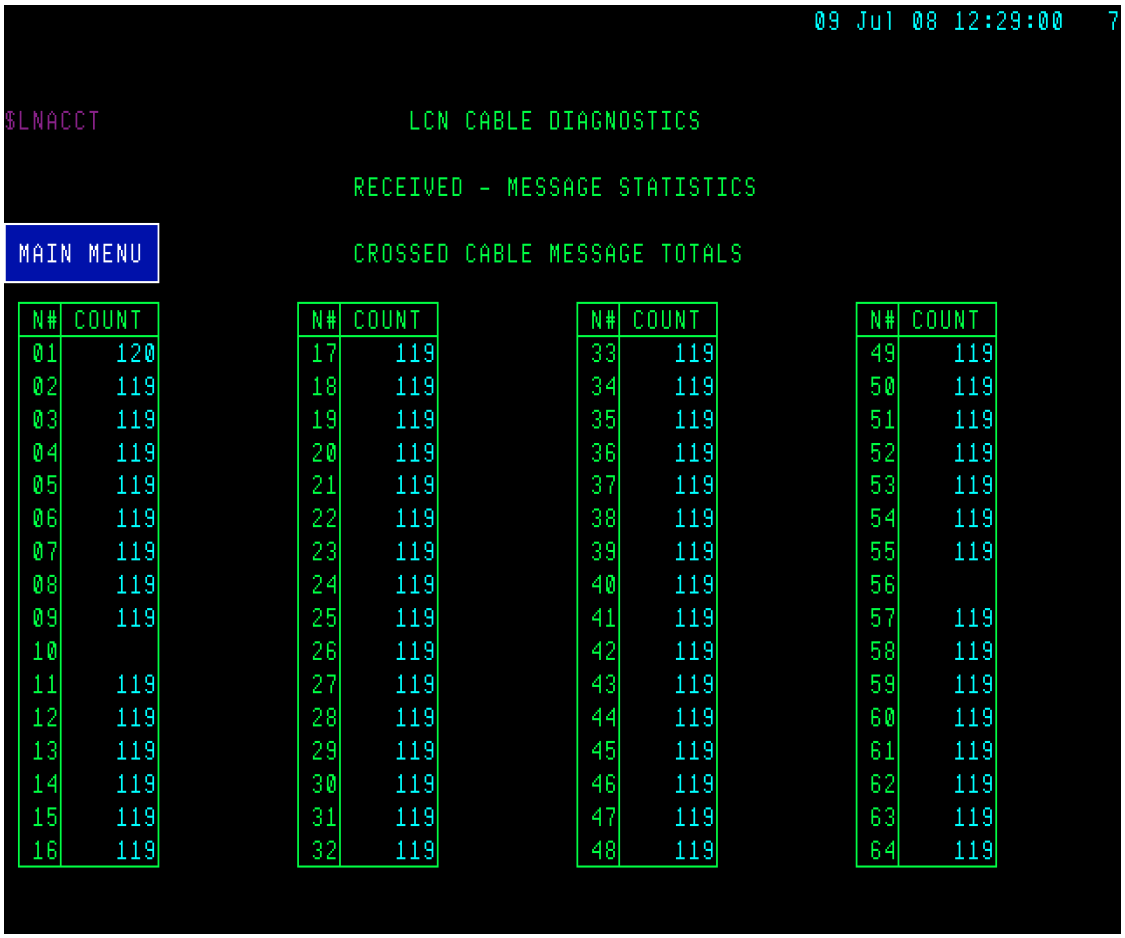
If the report is decreasing it means that the software was able to correct the hardware problem. If the report is increasing, it means that the software was unable to resolve the hardware problem and the board should be replaced with a new one.




| N# | CBL-A | CBL-B | N# | CBL-A | CBL-B | N# | CBL-A | CBL-B | N# | CBL-A | CBL-B |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 0 | 0 | 17 | 0 | 0 | 33 | 0 | 0 | 49 | 0 | 0 |
| 02 | 0 | 0 | 18 | 0 | 0 | 34 | 0 | 0 | 50 | 0 | 0 |
| 03 | 0 | 0 | 19 | 0 | 0 | 35 | 0 | 0 | 51 | 0 | 0 |
| 04 | 0 | 0 | 20 | 0 | 0 | 36 | 0 | 0 | 52 | 0 | 0 |
| 05 | 0 | 0 | 21 | 0 | 0 | 37 | 0 | 0 | 53 | 0 | 0 |
| 06 | 0 | 0 | 22 | 0 | 0 | 38 | 0 | 0 | 54 | 0 | 0 |
| 07 | 0 | 0 | 23 | 0 | 0 | 39 | 0 | 0 | 55 | 0 | 0 |
| 08 | 0 | 0 | 24 | 0 | 0 | 40 | 0 | 0 | 56 | | |
| 09 | 0 | 0 | 25 | 0 | 0 | 41 | 0 | 0 | 57 | 0 | 0 |
| 10 | | | 26 | 0 | 0 | 42 | 0 | 0 | 58 | 0 | 0 |
| 11 | 0 | 0 | 27 | 0 | 0 | 43 | 0 | 0 | 59 | 0 | 0 |
| 12 | 0 | 0 | 28 | 0 | 0 | 44 | 0 | 0 | 60 | 0 | 0 |
| 13 | 0 | 0 | 29 | 0 | 0 | 45 | 0 | 0 | 61 | 0 | 0 |
| 14 | 0 | 0 | 30 | 0 | 0 | 46 | 0 | 0 | 62 | 0 | 0 |
| 15 | 0 | 0 | 31 | 0 | 0 | 47 | 0 | 0 | 63 | 0 | 0 |
| 16 | 0 | 0 | 32 | 0 | 0 | 48 | 0 | 0 | 64 | 0 | 0 |

The “Media Dead” display should display “0” for all nodes for Cable A and Cable B. If it doesn’t, then the system has been reporting errors and these errors need to be cleared by going further in the $LNMENU display. The cause could be picked up by calling up the Cable A&B Rates.
If the Cable A&B rates indicate a value other than “0”, then the “LOCAL DRIVER DATA” display can be used to determine communication problems by specifying each node.

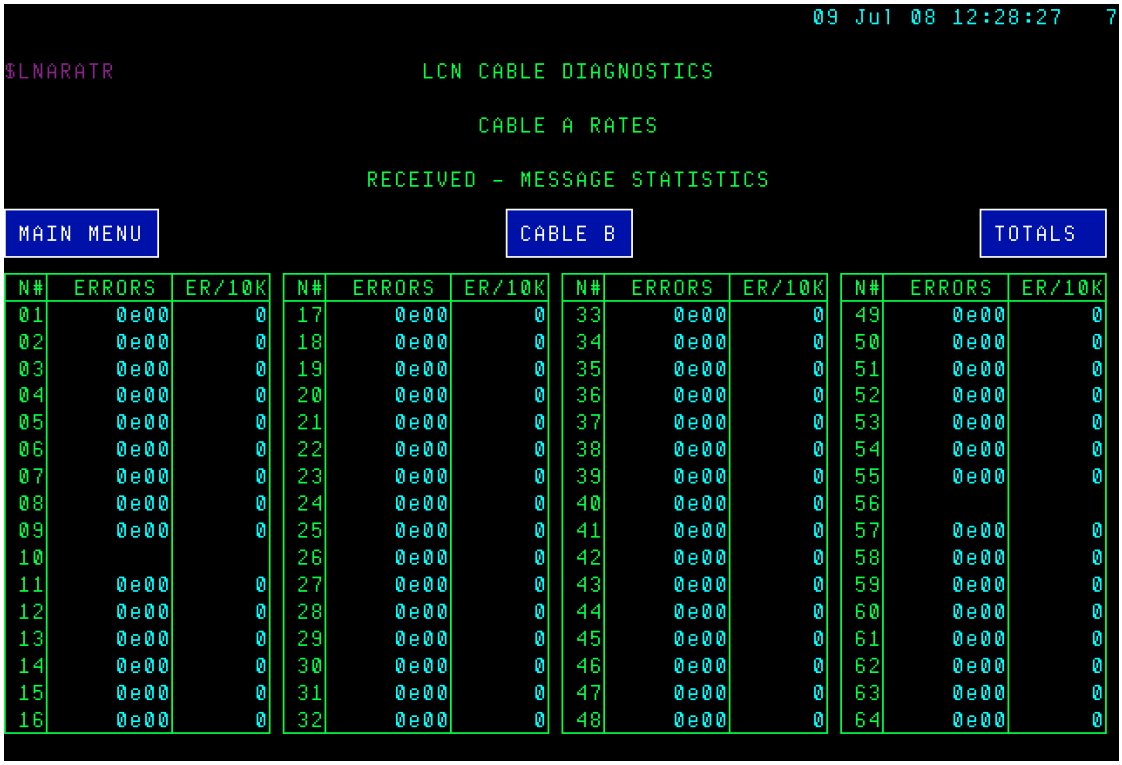
Check the values for Drive Errors, Output Packets Lost, Transmit Errors, received IOCB Errors, and LCN Recovery retries. If any of these values are other than “0”, then there is an indication that there is a LCN communications problem.




The lowest US node (cable Master) which contains the K4 or K2 (if K2, the LCN Firmware must be revision P or greater) will check for crossed cables. The lowest US which meets this conditions, will have a count "one" higher or "one" lower than the rest of the nodes. In this case it will be Node 01.

If this is true, then there are no crossed cables. If there is a node(s) which have different values, then that node(s) has the LCN cable crossed. Shutdown the node(s) 2 times to place them into the failed state and then power down the node. Reverse the tees on this node(s) and then power it up and reload it. Once the cables swap the next time, all nodes will be one more or less than the cable master.

The following snapshots were made of the system. The errors on the system have been cleared before the LCN audit was done. The snapshots can be used as a baseline to determine if errors will increase on the LCN.



09 Jul 08 12:28:27 7

$LNARATR

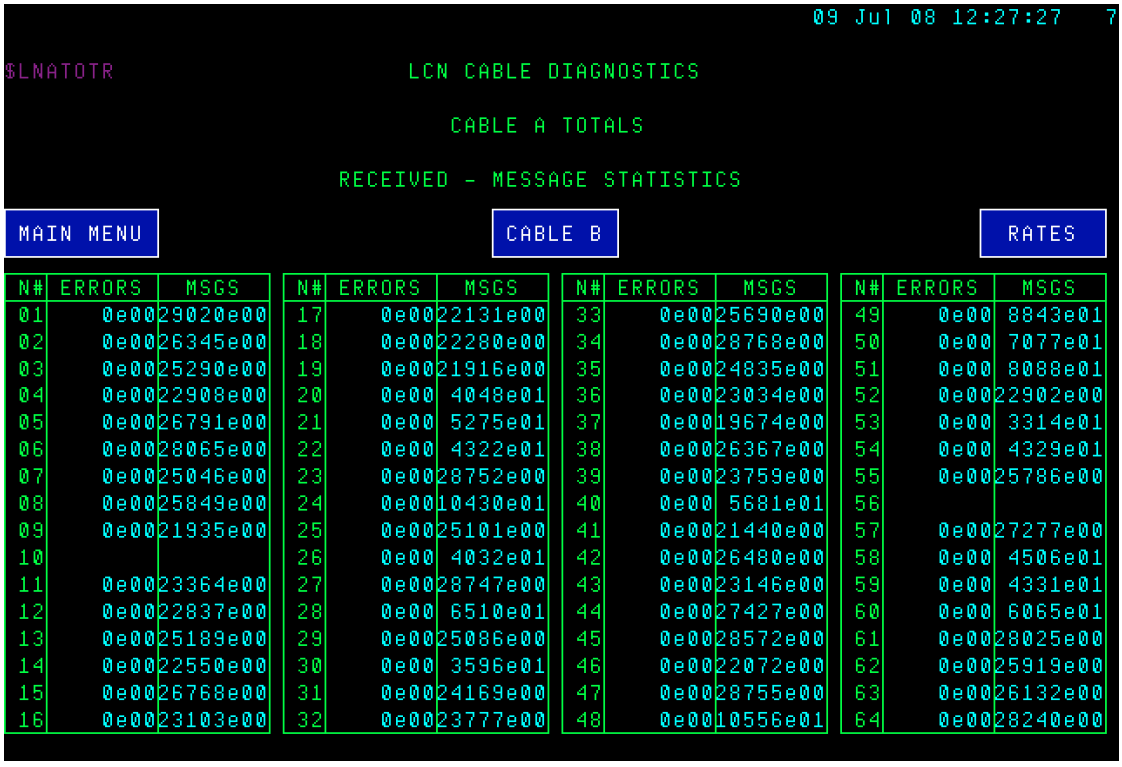
LCN CABLE DIAGNOSTICS

CABLE A RATES

RECEIVED - MESSAGE STATISTICS

MAIN MENU | CABLE B | TOTALS

| N# | ERRORS | ER/10K | N# | ERRORS | ER/10K | N# | ERRORS | ER/10K | N# | ERRORS | ER/10K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 0e00 | 0 | 17 | 0e00 | 0 | 33 | 0e00 | 0 | 49 | 0e00 | 0 |
| 02 | 0e00 | 0 | 18 | 0e00 | 0 | 34 | 0e00 | 0 | 50 | 0e00 | 0 |
| 03 | 0e00 | 0 | 19 | 0e00 | 0 | 35 | 0e00 | 0 | 51 | 0e00 | 0 |
| 04 | 0e00 | 0 | 20 | 0e00 | 0 | 36 | 0e00 | 0 | 52 | 0e00 | 0 |
| 05 | 0e00 | 0 | 21 | 0e00 | 0 | 37 | 0e00 | 0 | 53 | 0e00 | 0 |
| 06 | 0e00 | 0 | 22 | 0e00 | 0 | 38 | 0e00 | 0 | 54 | 0e00 | 0 |
| 07 | 0e00 | 0 | 23 | 0e00 | 0 | 39 | 0e00 | 0 | 55 | 0e00 | 0 |
| 08 | 0e00 | 0 | 24 | 0e00 | 0 | 40 | 0e00 | 0 | 56 | | |
| 09 | 0e00 | 0 | 25 | 0e00 | 0 | 41 | 0e00 | 0 | 57 | 0e00 | 0 |
| 10 | | | 26 | 0e00 | 0 | 42 | 0e00 | 0 | 58 | 0e00 | 0 |
| 11 | 0e00 | 0 | 27 | 0e00 | 0 | 43 | 0e00 | 0 | 59 | 0e00 | 0 |
| 12 | 0e00 | 0 | 28 | 0e00 | 0 | 44 | 0e00 | 0 | 60 | 0e00 | 0 |
| 13 | 0e00 | 0 | 29 | 0e00 | 0 | 45 | 0e00 | 0 | 61 | 0e00 | 0 |
| 14 | 0e00 | 0 | 30 | 0e00 | 0 | 46 | 0e00 | 0 | 62 | 0e00 | 0 |
| 15 | 0e00 | 0 | 31 | 0e00 | 0 | 47 | 0e00 | 0 | 63 | 0e00 | 0 |
| 16 | 0e00 | 0 | 32 | 0e00 | 0 | 48 | 0e00 | 0 | 64 | 0e00 | 0 |



09 Jul 08 12:27:27 7

$LNATOTR

LCN CABLE DIAGNOSTICS

CABLE A TOTALS

RECEIVED - MESSAGE STATISTICS

MAIN MENU | CABLE B | RATES

| N# | ERRORS | MSGS | N# | ERRORS | MSGS | N# | ERRORS | MSGS | N# | ERRORS | MSGS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 0e00 | 29020e00 | 17 | 0e00 | 22131e00 | 33 | 0e00 | 25690e00 | 49 | 0e00 | 8843e01 |
| 02 | 0e00 | 26345e00 | 18 | 0e00 | 22280e00 | 34 | 0e00 | 28768e00 | 50 | 0e00 | 7077e01 |
| 03 | 0e00 | 25290e00 | 19 | 0e00 | 21916e00 | 35 | 0e00 | 24835e00 | 51 | 0e00 | 8088e01 |
| 04 | 0e00 | 22908e00 | 20 | 0e00 | 4048e01 | 36 | 0e00 | 23034e00 | 52 | 0e00 | 22902e00 |
| 05 | 0e00 | 26791e00 | 21 | 0e00 | 5275e01 | 37 | 0e00 | 19674e00 | 53 | 0e00 | 3314e01 |
| 06 | 0e00 | 28065e00 | 22 | 0e00 | 4322e01 | 38 | 0e00 | 26367e00 | 54 | 0e00 | 4329e01 |
| 07 | 0e00 | 25046e00 | 23 | 0e00 | 28752e00 | 39 | 0e00 | 23759e00 | 55 | 0e00 | 25786e00 |
| 08 | 0e00 | 25849e00 | 24 | 0e00 | 10430e01 | 40 | 0e00 | 5681e01 | 56 | | |
| 09 | 0e00 | 21935e00 | 25 | 0e00 | 25101e00 | 41 | 0e00 | 21440e00 | 57 | 0e00 | 27277e00 |
| 10 | | | 26 | 0e00 | 4032e01 | 42 | 0e00 | 26480e00 | 58 | 0e00 | 4506e01 |
| 11 | 0e00 | 23364e00 | 27 | 0e00 | 28747e00 | 43 | 0e00 | 23146e00 | 59 | 0e00 | 4331e01 |
| 12 | 0e00 | 22837e00 | 28 | 0e00 | 6510e01 | 44 | 0e00 | 27427e00 | 60 | 0e00 | 6065e01 |
| 13 | 0e00 | 25189e00 | 29 | 0e00 | 25086e00 | 45 | 0e00 | 28572e00 | 61 | 0e00 | 28025e00 |
| 14 | 0e00 | 22550e00 | 30 | 0e00 | 3596e01 | 46 | 0e00 | 22072e00 | 62 | 0e00 | 25919e00 |
| 15 | 0e00 | 26768e00 | 31 | 0e00 | 24169e00 | 47 | 0e00 | 28755e00 | 63 | 0e00 | 26132e00 |
| 16 | 0e00 | 23103e00 | 32 | 0e00 | 23777e00 | 48 | 0e00 | 10556e01 | 64 | 0e00 | 28240e00 |

09 Jul 08 12:28:14 7

$LNBRATR

LCN CABLE DIAGNOSTICS

CABLE B RATES

RECEIVED - MESSAGE STATISTICS

MAIN MENU | CABLE A | TOTALS

| N# | ERRORS | ER/10K | N# | ERRORS | ER/10K | N# | ERRORS | ER/10K | N# | ERRORS | ER/10K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 0e00 | 0 | 17 | 0e00 | 0 | 33 | 0e00 | 0 | 49 | 0e00 | 0 |
| 02 | 0e00 | 0 | 18 | 0e00 | 0 | 34 | 0e00 | 0 | 50 | 0e00 | 0 |
| 03 | 0e00 | 0 | 19 | 0e00 | 0 | 35 | 0e00 | 0 | 51 | 0e00 | 0 |
| 04 | 0e00 | 0 | 20 | 0e00 | 0 | 36 | 0e00 | 0 | 52 | 0e00 | 0 |
| 05 | 0e00 | 0 | 21 | 0e00 | 0 | 37 | 0e00 | 0 | 53 | 0e00 | 0 |
| 06 | 0e00 | 0 | 22 | 0e00 | 0 | 38 | 0e00 | 0 | 54 | 0e00 | 0 |
| 07 | 0e00 | 0 | 23 | 0e00 | 0 | 39 | 0e00 | 0 | 55 | 0e00 | 0 |
| 08 | 0e00 | 0 | 24 | 0e00 | 0 | 40 | 0e00 | 0 | 56 | | |
| 09 | 0e00 | 0 | 25 | 0e00 | 0 | 41 | 0e00 | 0 | 57 | 0e00 | 0 |
| 10 | | | 26 | 0e00 | 0 | 42 | 0e00 | 0 | 58 | 0e00 | 0 |
| 11 | 0e00 | 0 | 27 | 0e00 | 0 | 43 | 0e00 | 0 | 59 | 0e00 | 0 |
| 12 | 0e00 | 0 | 28 | 0e00 | 0 | 44 | 0e00 | 0 | 60 | 0e00 | 0 |
| 13 | 0e00 | 0 | 29 | 0e00 | 0 | 45 | 0e00 | 0 | 61 | 0e00 | 0 |
| 14 | 0e00 | 0 | 30 | 0e00 | 0 | 46 | 0e00 | 0 | 62 | 0e00 | 0 |
| 15 | 0e00 | 0 | 31 | 0e00 | 0 | 47 | 0e00 | 0 | 63 | 0e00 | 0 |
| 16 | 0e00 | 0 | 32 | 0e00 | 0 | 48 | 0e00 | 0 | 64 | 0e00 | 0 |

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$LNBTOTR

LCN CABLE DIAGNOSTICS

CABLE B TOTALS

RECEIVED - MESSAGE STATISTICS

MAIN MENU | CABLE A | RATES

| N# | ERRORS | MSGS | N# | ERRORS | MSGS | N# | ERRORS | MSGS | N# | ERRORS | MSGS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 0e00 | 28237e00 | 17 | 0e00 | 21255e00 | 33 | 0e00 | 25309e00 | 49 | 0e00 | 8698e01 |
| 02 | 0e00 | 25580e00 | 18 | 0e00 | 21923e00 | 34 | 0e00 | 28014e00 | 50 | 0e00 | 6960e01 |
| 03 | 0e00 | 24410e00 | 19 | 0e00 | 20732e00 | 35 | 0e00 | 24101e00 | 51 | 0e00 | 7944e01 |
| 04 | 0e00 | 22717e00 | 20 | 0e00 | 3978e01 | 36 | 0e00 | 22374e00 | 52 | 0e00 | 22361e00 |
| 05 | 0e00 | 26553e00 | 21 | 0e00 | 5164e01 | 37 | 0e00 | 19058e00 | 53 | 0e00 | 32638e00 |
| 06 | 0e00 | 27771e00 | 22 | 0e00 | 4249e01 | 38 | 0e00 | 24850e00 | 54 | 0e00 | 4307e01 |
| 07 | 0e00 | 24163e00 | 23 | 0e00 | 28171e00 | 39 | 0e00 | 22310e00 | 55 | 0e00 | 25041e00 |
| 08 | 0e00 | 25676e00 | 24 | 0e00 | 10246e01 | 40 | 0e00 | 5773e01 | 56 | | |
| 09 | 0e00 | 21037e00 | 25 | 0e00 | 24532e00 | 41 | 0e00 | 20082e00 | 57 | 0e00 | 26777e00 |
| 10 | | | 26 | 0e00 | 3932e01 | 42 | 0e00 | 25798e00 | 58 | 0e00 | 4446e01 |
| 11 | 0e00 | 22787e00 | 27 | 0e00 | 28163e00 | 43 | 0e00 | 21657e00 | 59 | 0e00 | 4269e01 |
| 12 | 0e00 | 22361e00 | 28 | 0e00 | 6376e01 | 44 | 0e00 | 24481e00 | 60 | 0e00 | 5973e01 |
| 13 | 0e00 | 24348e00 | 29 | 0e00 | 24536e00 | 45 | 0e00 | 27966e00 | 61 | 0e00 | 27399e00 |
| 14 | 0e00 | 22243e00 | 30 | 0e00 | 3537e01 | 46 | 0e00 | 21112e00 | 62 | 0e00 | 25363e00 |
| 15 | 0e00 | 25923e00 | 31 | 0e00 | 23742e00 | 47 | 0e00 | 28154e00 | 63 | 0e00 | 25583e00 |
| 16 | 0e00 | 22778e00 | 32 | 0e00 | 23297e00 | 48 | 0e00 | 10379e01 | 64 | 0e00 | 27581e00 |

## *5.* Recommendations

### *5.1. MAU*

The MAU located at GUS 44 should have the MAU and tee's replaced. Also the location of this MAU needs to be relocated from the sub-floor space to an environmental stable position.

### *5.2. Earthing*

The earthing guidelines should be reviewed and applied to each node on the LCN.
A more detailed scope of work needs to be created to define the action per node and implementation of a corrective action plan.

Further details of earthing principles for a TPS system is found in Honeywell guide TPS system Site Planning SW02-550

No testing was made of the earthing points. It is recommended to test and inspected these and to document the results. This should be included in a preventative maintenance plan per annum.

### *5.3. LCN Cabling*

All excessive cabling should be removed from the LCN. There were many connections in the LCN that had no requirement for equipment needs or operation needs. Honeywell recommends removal of all unused tees.

Require accurate documentation of the LCN cable path and segmental lengths, it should also note the physical path, cable part numbers and location of any connections. A review of this document should be included in a preventative maintenance plan per annum at minimum and update the document as LCN changes occur between reviews.

The LCN cabling should be labelled such to provide information of the source and/or destination of the cable.

It is also recommend replacing all end termination resistors of the LCN and documenting the location of these.

All LCN cabling should have a minimum separation of 30 centimetres from power cabling. Every attempt should be made to ensure this is complied to.

### *5.4. Other*

A review of the environment conditions of the LCN equipment needs to be checked, i.e. humidity and temperature are being controlled within Honeywell recommended limits. This should be monitored and recorded at regular intervals.

Replace all LCNE2 boards with XLCNE2 boards as per service bulletin MP-0109-01A.

No review was conducted on the Hot Spare system. A review should be done and guidelines of this report should be followed.

Once all of the recommendations are actioned a review should be conducted again to measure impact of changes and stability of LCN communications.

If no improvements are observed in the LCN communications then further testing needs to be conducted. This could include but not limited to LCN Noise measurements, LCN cable testing, and active testing of the earthing system.

## Appendix A: Gather LCN Audit Data

| 4/07/2008 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Equipment** | **T Terminators** | **LCNE** | **LCN** | **LCN Labelled** | **Crimping @** | **Grounding** | **MAU** | | **Joined with** | **General Condition** | **Comments** |
| | **Locked in Place** | | **Paddle Board** | | **Connectors** | **LCN not** | **Connectors** | | **T Connector** | | |
| | | | | | | **Grounded** | **Zinc** | **Aluminium** | | | **Source or Destination Labels on LCN Cables unreliable - All Cabinets** |
| **AREA NORTH** | | | | | | | | | | | |
| US 01 | Y | N | Y | Y | Good | Linked | | | N | OK | |
| US 02 | Y | N | Y | Y | Good | Linked | | | N | OK | |
| US 03 | Y | N | Y | Y | Good | Linked | | | N | OK | |
| US 04 | Y | N | Y | Y | Good | Linked | | | N | OK | |
| US 05 | Y | N | Y | Y | Good | N | | | N | OK | |
| US 06 | Y | N | Y | Y | Good | N | | | N | OK | |
| US 07 (Main operator) | Not visible | N | Y | Not visible | Not visible | Not visible | | | N | Dirty | To be cleaned |
| US 08 | Y | N | Y | Y | Not Good | N | | | N | OK | Tight fit on T Connectors A/B; No Chassis Ground |
| US 09 | Y | N | Y | Y | Good | N | | | N | OK | |
| | | | | | | | | | | | |
| **AREA EAST** | | | | | | | | | | | |
| US 31 | Y | N | Y | Y | Good | N | | | N | OK | |
| US 32 | Y | N | Y | Y | Good | N | | | N | OK | |
| US 33 | Y | N | Y | Y | Good | N | | | N | OK | |
| US 34 | Y | N | Y | Y | Good | N | | | N | OK | |
| US 35 | Y | N | Y | Y | Good | N | | | N | OK | |
| US 36 | Y | N | Y | Y | Good | N | | | N | Untidy | Cables to be tidied up |
| US 37 (Main Operator) | Not visible | N | Y | Not visible | Not visible | Not visible | | | N | Dirty | To be cleaned |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **AREA SOUTH** | | | | | | | | | | | |
| US 11 | Y | N | Y | Y | Good | Linked | | | N | Untidy | Cables to be tidied up |
| US 12 | Y | N | Y | Y | Good | Linked | | | N | Untidy | Cables to be tidied up |
| US 13 | Y | N | Y | Y | Good | Linked | | | | Untidy | Cables to be tidied up |
| US 14 | Y | N | Y | Y | Good | Linked | | | N | Untidy | Cables to be tidied up |
| US 15 | Y | N | Y | Y | Good | Linked | | | N | Untidy | Cables to be tidied up |
| US 16 | Y | N | Y | Y | Good | Linked | | | N | Untidy | Cables to be tidied up |
| US 17 (Main Operator) | Not visible | N | Y | Not visible | Not visible | Not visible | | | N | Dirty | To be cleaned |
| US 18 | Y | N | Y | Y | Good | Linked | | | N | Untidy | Cables to be tidied up |
| | | | | | | | | | | | |
| **AREA Movements** | | | | | | | | | | | |
| EST 38 | Y | N | N | Y | Good | N | | Y | N | Good | Cabinet very dusty inside, to be cleaned out |
| DVM 43 | | | | | | N | | | | | Cabinet very dusty inside, to be cleaned out |
| EST 39 | Y | N | N | Y | Good | N | | Y | N | Good | Cabinet very dusty inside, to be cleaned out |
| MOVECOC3 | Y | N | N | Y | Good | | | Y | N | Good | Cabinet very dusty inside, to be cleaned out |
| | | | | | | | | | | | |
| **Engineering Stations** | | | | | | | | | | | |
| US 09 | Y | N | Y | N | Good | N | | | Y | Good | LCN A/B joined with 3 open T's under floor |
| Pilot Server | Y | N | N | Y | Good | N | | Y | Y | Good | Terminated at Mau under floor; Another Mau with LCN cables but no connection, |
| | | | | | | | | | | | and open T's on LCN A/B under floor |
| Gus 44 | Y | N | N | N | Good | N | | Y Corroded | N | Good | LCN A/B not labelled at T, Connections on MAU Corroded |
| Gus 40 | Y | N | N | N | Good | N | | Y | N | Good | |
| Powered down US | Y | N | Y | N | Good | N | | | N | Good | Node powered down, but still connected to LCN A/B |
| US 41 | Y | N | Y | N | Good | N | | | N | Good | LCN A/B not labelled at T |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| US 42 | Y | N | Y | N | Good | N | | | N | Good | LCN A/B not labelled at T |
| Node 58 - Pilot | Y | N | N | Y | Good | N | | Y | N | Good | |
| APP Node 53 (Computer Room) | Y | N | N | Y | Not Visible | N | | Y | N | Good | |
| APP Node 20 (Computer Room) | Y | N | N | Y | Not Visible | N | | Y | N | Good | |
| | | | | | | | | | | | |
| **Cabinet 37-CAB-LCN1 Rear** | | | | | | | | | | Cabling Untidy | Cables to be tidied up |
| HM 61 | Y | N | Y | N | Good | N | | | N | OK | LCN A not labelled at T |
| NIM 45 (P) | Y | N | Y | N | Good | Linked | | | N | OK | LCN B not labelled at T; Logic and Chassis ground shorted out |
| NIM 46 | Y | N | Y | N | Good | N | | | N | OK | LCN A/B not labelled at T |
| AM 49 | Y | N | Y | N | Good | N | | | N | OK | LCN A/B not labelled at T |
| NIM 23 (LCNE A Fibre Optic) | Y | Y | Y | N | Good | N | | | N | OK | LCN A/B not labelled at T |
| NIM 24 (LCNE B Fibre Optic) | Y | Y | Y | N | Good | N | | | N | OK | LCN A/B not labelled at T |
| | | | | | | | | | | | |
| **Cabinet 37-CAB-LCN2 Rear** | | | | | | | | | | OK | |
| HM 63 Drives | Y | N | Y | N | Good | N | | | N | OK | LCN A/B not labelled at T |
| HG 29 (P) | Y | Y | Y | N | Good | N | | | N | OK | LCN A/B not labelled at T; LCNE not used |
| HG 30 | Y | Y | Y | N | Good | N | | | N | OK | LCN A/B not labelled at T; LCNE not used |
| | | | | | | | | | | | |
| **Cabinet 37-CAB-LCN3 Rear** | | | | | | | | | | Spare LCN cable | Spare Fibre Optic Cable To Sat Room 2; Spare 3m LCN Segment? |
| HM 59 Redundant Drives | Y | N | Y | N | Good | N | | | N | OK | LCN A/B not labelled at T |
| HG 25 (P) (LCNE - No Fibre Optic) | Y | Y | Y | N | Good | N | | | Y | Untidy | LCN A/B not labelled at T; Cables to be tidied up; A/B joined with open T's |
| HG 26 (LCNE - No Fibre Optic) | Y | Y | Y | N | Good | N | | | N | OK | LCN A/B not labelled at T |
| | | | | | | | | | | | |
| **Cabinet 37-CAB-LCN4 Rear** | | | | | | | | | | LCN Cables | LCN cables to be tidied up |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Node 52 - No Label | Y | N | Y | Y | Good | N | | | N | OK | |
| HM 62 Drives | Y | N | Y | Y | Good | N | | | N | OK | |
| AM 50 | Y | N | Y | N | Good | N | | | N | OK | LCN A/B not labelled at T |
| NIM 27 (P) | Y | N | Y | N | Good | N | | | N | Untidy | LCN A/B not labelled at T; LCN cables to be tidied up |
| NIM 28 | Y | N | Y | N | Good | N | | | N | Untidy | LCN A not labelled at T; LCN cables to be tidied up |
| | | | | | | | | | | | |
| **Cabinet 37-CAB-LCN5 Rear** | | | | | | | | | | Untidy | LCN cables to be tidied up |
| APP 21 SRV 2 | Y | N | N | Y | Good | N | | Y | Y | Untidy | LCN A/B joined with open T's |
| APP 22 SRV 2 | Y | N | N | N | Good | N | | Y | Y | Untidy | LCN A/B joined with open T's, LCN A/B not labelled at T |
| KVM Switch | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Cabinet 37-CAB-LCN6 Rear** | | | | | | | | | | Cables untidy | LCN T and cables to be removed |
| HM 64 Disk Drives 1 & 2 | Y | N | Y | N | Good | N | | | N | Cables untidy | LCN A/B not labelled at T |
| HG 56 (Turned Off) | Y | N | Y | N | Good | N | | | N | Cables untidy | LCN B not labelled at T |
| APP 54 | Y | N | Y | N | Good | N | | | N | Cables untidy | LCN A/B not labelled at T |
| APP 51 | Y | N | Y | N | Good | N | | | N | Cables untidy | LCN A/B not labelled at T |
| NIM 47 (P) (LCNE Fibre Optic) | Y | Y | Y | Y | Good | N | | | N | Cables untidy | |
| NIM 48 (LCNE Fibre Optic) | Y | Y | Y | N | Good | N | | | Y | Cables untidy | LCN A/B joined with open T's, LCN A not labelled at T |
| | | | | | | | | | | | |
| **Cabinet 37-CAB-LCN7 Rear** | | | | | | | | | | | |
| Cable Switch - Catalyst 3750 | | | | | | | | | | | |
| Cable Switch - Catalyst 3750 | | | | | | | | | | | |
| Cable Switch - Catalyst 2960 | | | | | | | | | | | |
| EASTCERCNVL2A1 | | | | | | | | | | | |
| EASTCOF1 | | | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LCN 7 KVM | | | | | | | | | | | |
| MOVAPPM1 | Y | N | N | Y | Good | N | | Y | N | | New cabinet - still busy to tidy up |
| SITEAPPM1 | Y | N | N | Y | Good | N | | Y | N | | |
| EASTESVT1A | Y | N | N | Y | Good | N | | Y | N | | |
| SITEMSDC1A | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Cabinet 37-CAB-LCN8 Rear** | | | | | | | | | | | |
| Cable Switch - Catalyst 3750 | | | | | | | | | | | |
| Cable Switch - Catalyst 3750 | | | | | | | | | | | |
| Cable Switch - Catalyst 2960 | | | | | | | | | | | |
| EASTCERCNVL2B1 | | | | | | | | | | | |
| EASTCOF2 | | | | | | | | | | | |
| LCN 8 KVM | | | | | | | | | | | |
| SITEEVR1 | | | | | | | | | | | |
| EASTESVT1B | Y | N | N | Y | Good | N | | Y | N | Good | New cabinet - still busy to tidy up; 2 x Spare MAU's with no connection |
| EASTMSDC1A | | | | | | | | | | | |
| SITEMSDC1A | | | | | | | | | | | |

| 4/07/2008 | | | | | | | |
|---|---|---|---|---|---|---|---|
| - | Primary | Status | HeapMin | HeapFrag | ParSec | PFPSHLDB | CPU Free |
| - | | | | | | (HoldBrth) | |
| **LCN Equipment** | | | | | | | |
| **AREA NORTH** | | | | | | | |
| US 01 | | | 3.90E+06 | 0 | 4.07 | 2 | 93.62 |
| US 02 | | | 3.90E+06 | 0 | 4 | 0 | 93.06 |
| US 03 | | | 3.90E+06 | 0 | 4.07 | 0 | 61.89 |
| US 04 | | | 3.90E+06 | 0 | 4.07 | 0 | 95.56 |
| US 05 | | | 3.90E+06 | 0 | 4.07 | 0 | 70.37 |
| US 06 | | | 3.90E+06 | 0 | 4.07 | 0 | 93.09 |
| US 07 (Main operator) | | | 3.90E+06 | 0 | 4.07 | 0 | 20.2 |
| US 08 | | | 3.90E+06 | 0 | 4.07 | 0 | 93.44 |
| US 09 | | | 3.90E+06 | 0 | 4.07 | 0 | 96.14 |
| | | | | | | | |
| **AREA EAST** | | | | | | | |
| US 31 | | | 3.90E+06 | 0 | 4.07 | 2 | 92.63 |
| US 32 | | | 3.90E+06 | 0 | 4.07 | 15 | 95.82 |
| US 33 | | | 3.90E+06 | 0 | 4.07 | 1 | 79.36 |
| US 34 | | | 3.90E+06 | 0 | 4.33 | 2 | 92.09 |
| US 35 | | | 3.90E+06 | 0 | 4 | 1 | 94.03 |
| US 36 | | | 3.90E+06 | 0 | 4.07 | 0 | 82.11 |
| US 37 (Main Operator) | | | 3.90E+06 | 0 | 4.07 | 2 | 92.79 |
| | | | | | | | |
| **AREA SOUTH** | | | | | | | |
| US 11 | | | 3.90E+06 | 0 | 4.33 | 0 | 93.14 |
| US 12 | | | 3.90E+06 | 0 | 4.07 | 1 | 96.26 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| US 13 | | | 3.90E+06 | 0 | 4.07 | 0 | 77.54 |
| US 14 | | | 3.90E+06 | 0 | 4.07 | 0 | 94.94 |
| US 15 | | | 3.90E+06 | 0 | 5.27 | 0 | 80.71 |
| US 16 | | | 3.90E+06 | 0 | 4 | 2 | 94.14 |
| US 17 (Main Operator) | | | 3.90E+06 | 0 | 4.07 | 0 | 86.94 |
| US 18 | | | 3.90E+06 | 0 | 4.07 | 0 | 96 |
| US 19 | | | 3.90E+06 | 0 | 4.33 | 2 | 94.92 |
| | | | | | | | |
| **AREA Movements** | | | | | | | |
| EST 38 | | | 3.90E+06 | 0 | 4.33 | 0 | 94.75 |
| DVM 43 | | | 1.40E+06 | 0 | 4.07 | 0 | 94.91 |
| EST 39 | | | 3.90E+06 | 0 | 4.07 | 0 | 94.89 |
| | | | | | | | |
| **Engineering Stations** | | | | | | | |
| Pilot Server | | | | | | | |
| | | | | | | | |
| Gus 44 | | | 1.40E+06 | 0 | 4.4 | 0 | 95.19 |
| EST 40 | | | 1.30E+06 | 0 | 4.27 | 0 | 88.71 |
| Powered down US | | | | | | | |
| US 41 | | | 2.40E+06 | 0 | 4.07 | 0 | 99.11 |
| US 42 | | | 2.20E+06 | 0 | 4.07 | 0 | 82.77 |
| US 60 | | | 2.30E+06 | 0 | 0.07 | 2 | 75.25 |
| Node 58 - Pilot | | | 1.30E+06 | 0 | 4.33 | 0 | 81.28 |
| APP Node 53 (Computer Room) | | | 1.30E+06 | 0 | 7.2 | 12 | |
| APP Node 20 (Computer Room) | | | 1.20E+06 | 0 | 0.4 | 36 | 97.03 |
| EST 57 | | | 1.30E+06 | 0 | 4.53 | 0 | 87.53 |
| | | | | | | | |
| **HG 25 - HWY 2** | | | 5.90E+06 | 0 | 0.13 | 0 | 98.3 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **HG 26 - HWY 2** | P | | 5.90E+06 | 0 | 37.93 | 0 | 95.71 |
| | | | | | | | |
| **HG 29 - HWY 3** | | | 5.90E+06 | 0 | 0.2 | 0 | 98.48 |
| **HG 30 - HWY 3** | P | | 5.90E+06 | 0 | 32.73 | 0 | 96.26 |
| | | | | | | | |
| **HM 59** | | | 5.40E+06 | 0 | 0.2 | 0 | 94.31 |
| **HM 61** | | | 5.10E+06 | 0 | 0.07 | 24 | 95.95 |
| **HM 62** | | | 5.10E+06 | 0 | 0.07 | 2 | 87.97 |
| **HM 63** | | | 5.00E+06 | 0 | 0.13 | 37 | 91.87 |
| **HM 64** | | | 5.10E+06 | 0 | 0.2 | 2 | 90.76 |
| | | | | | | | |
| **AM 21** | | | 1.20E+06 | 1 | 190.2 | 13 | 85.48 |
| **AM 22** | | | 1.20E+06 | 1 | 124.73 | 16 | 88.26 |
| **AM 49** | | | 247296 | 0 | 46.93 | 148 | 84.74 |
| **AM 50** | | | 450708 | 0 | 12.47 | 9 | 90.63 |
| **AM 51** | | | 273223 | 0 | 55.07 | 62 | 87.69 |
| **AM 52** | | | 531834 | 0 | 0.2 | 10 | 97.47 |
| **AM 53** | | | 1.30E+06 | 0 | 2.13 | 12 | 89.16 |
| **AM 54** | | | 408349 | 0 | 21.47 | 295 | 94.26 |
| **AM 55** | | | 719989 | 0 | 0.6 | 0 | 92.98 |
| | | | | | | | |
| **NIM 23** | | | 4.50E+06 | 0 | 0.2 | 0 | 98.06 |
| **NIM 24** | P | | 4.50E+06 | 0 | 652.27 | 0 | 72.65 |
| **NIM 27** | | | 4.50E+06 | 0 | 0.07 | 0 | 97.8 |
| **NIM 28** | P | | 4.50E+06 | 0 | 220.2 | 0 | 83.74 |
| **NIM 45** | | | 4.50E+06 | 0 | 0.07 | 0 | 98.13 |
| **NIM 46** | P | | 4.50E+06 | 0 | 1.27 | 0 | 96.71 |
| **NIM 47** | | | 4.50E+06 | 0 | 0.13 | 0 | 98.06 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **NIM 48** | P | | 4.50E+06 | 0 | 558.2 | 0 | 73.3 |
| | | | | | | | |
| **The following are guidelines for LCN performance. Start with PARSEC when diagnosing a problem.** | | | | | | | |
| SECTION I | | | | | | | |
| PSDP parameters relevant to performance: | | | | | | | |
| CPUFREE - consistent averages below 15-20% are undesirable | | | | | | | |
| HEAPMIN - Values over 100,000 are desirable though AMs can operate with as little as 40,000 | | | | | | | |
| HEAPFRAG - Values at or above 2 indicate potentially fatal condition | | | | | | | |
| PARSEC - Recommended Maximums: | | | | | | | |
| | NG = 3600 for 68040, 1200 for 68020 | | | | | | |
| | AM = 615 for 68040, 410 for 68020 | | | | | | |
| | HG = 960 for 68040, 630 for 68020 | | | | | | |
| | NIM = 1400 for 68040, 750 for 68020 | | | | | | |
| PFPSHLDB - Consistently increasing values indicate overloading on other nodes | | | | | | | |